WHAT IS CLAIMED IS:

1. A method for detecting a line-to-line fault location in a power network comprising the steps of:

determining elements of a line impedance matrix and a load impedance matrix, and phase voltages and currents at a relay;

determining a line-to-line fault distance d by substituting said elements of said line impedance matrix and said load impedance matrix, and said phase voltage and current into a fault location equation based on direct circuit analysis;

wherein said fault location equation is derived from a model consisting of said phase voltage and current at the relay, a fault current, a fault resistance and the line-to-line fault distance;

wherein the model is based on the line-to-line fault between a-phase and b-phase and described by a model equation:

$$V_{Sa} - V_{Sb} = (1-d)((Zl_{aa} - Zl_{ba})I_{Sa} + (Zl_{ab} - Zl_{bb})I_{Sb} + (Zl_{ac} - Zl_{cb})I_{Sc}) + I_f R_f ,$$

where, $V_{Sabc} = [V_{Sa} \quad V_{Sb} \quad V_{Sc}]^{t}$: phase voltage vector, $I_{Sabc} = [I_{Sa} \quad I_{Sb} \quad I_{Sc}]^{t}$: phase current vector, $Zl_{abc} = \begin{bmatrix} Zl_{aa} & Zl_{ab} & Zl_{ac} \\ Zl_{ba} & Zl_{bb} & Zl_{bc} \\ Zl_{ca} & Zl_{cb} & Zl_{cc} \end{bmatrix}$: line impedance matrix, I_f: fault current, 1-d: fault distance;

wherein said fault location equation is derived by using the matrix inverse lemma: $(A^{-1} + BCD)^{-1} = A - AB(C^{-1} + DAB)^{-1} DA$, to simplify an inverse matrix calculation; and

wherein the fault location equation is derived by direct circuit analysis without using the conventional symmetrical component transformation method.

2. The method of claim 1, wherein the power network is a 3-phase balanced network.

3. The method of claim 1, wherein the power network is a 3-phase unbalanced network.

4. The method of claim 1, wherein the fault location equation is derived by steps of:

(a) expressing the fault current I_f in terms of the phase current vector I_s by using current distribution law of a parallel network yielding: $\begin{bmatrix} I_f \\ 0 \\ 0 \end{bmatrix} = Y_f[Y_f + (dZl_{abc} + Zr_{abc})^{-1}]^{-1} \begin{bmatrix} I_{Sa} \\ I_{Sb} \\ I_{Sc} \end{bmatrix}$, where $Y_f = \begin{bmatrix} 1/R_f & -1/R_f & 0 \\ -1/R_f & 1/R_f & 0 \\ 0 & 0 & 0 \end{bmatrix}$: fault admittance matrix and $Zr_{abc} = \begin{bmatrix} Zr_{aa} & Zr_{ab} & Zr_{ac} \\ Zr_{ba} & Zr_{bb} & Zr_{bc} \\ Zr_{ca} & Zr_{cb} & Zr_{cc} \end{bmatrix}$: load impedance matrix;

(b) simplifying the equation of step (a) by using the inverse matrix lemma and substituting the simplified equation into the model equation;

(c) deriving a second order polynomial equation with respect to the line-to-line fault distance d from a real or an imaginary part of the equation obtained at step (b); and

(d) deriving the fault location equation by solving the second order polynomial equation.